MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

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Lord LINDSAY, M.P., F.R.S., President, in the Chair.

The Rev. Abraham Smith, Collegiate School, Huddersfield; and

Lewis Swift, Esq., Rochester, New York, U.S.;

were balloted for and duly elected Fellows of the Society.

The President addressed the Meeting:—

"I deeply regret having to announce to the Society the news of the death of Mons. Edmond de Chazal, of St. Antoine, Mauritius. In bringing before your notice the decease of a gentleman who was not a Fellow of the Society, I may be, strictly speaking, out of order; but I feel sure that I shall be pardoned by the Society for recording publicly our feelings. I do not wish to speak of Mons. de Chazal as a personal friend for whom I held the highest esteem, but rather as a citizen of the world, who, mindful of the difficulties found in discussing the observations of the transits of *Venus* last century, owing to the uncertainty of the exact localities of the observers, placed in the hands of Her Majesty's Government a deed conveying to it the site of the Observatory I raised in the island.

"The interest he took in my work was only equalled by his tender kindness during my illness."

Extract from a Letter from Professor Asaph Hall to the Astronomer Royal.

I am glad to see, in the *Monthly Notices* of December 1878, your Note on the mass of *Mars*. Although the volume containing your paper has stood within a few feet of me for several years, I missed it in looking up the authorities on this question. The recent Note of Mr. Dunkin on the Tables of *Saturn* by Le Verrier

is interesting. My observations of the satellites of this planet are not yet discussed, but they indicate that Bessel's value of the mass of *Saturn* is nearly correct. I think that Le Verrier made some error in the perturbations of *Jupiter* and *Saturn*, by which he got some of his coefficients too large, and then, in adjusting his theory to fit the observations, he was led to diminish the mass of *Saturn*. Mr. G. W. Hill is at work on the complicated theory of *Jupiter* and *Saturn*, and in the course of two or three years we may expect his results.

In the theory of *Hyperion* I think that I have got hold of an interesting motion of the line of apsides; the observations of this satellite hitherto made are so clustered about the elongations that the elements remain somewhat uncertain, but after two years I shall be able to follow all around the planet this faint object.

Naval Observatory, Washington,
1879, *February* 18.

An apparently New Variable Star. By J. L. E. Dreyer, Esq.

On March 8, when observing the red star Schj. 109 (Lal. 16770 = Weisse I, $8^h.625$ = Schj. 3122), I remarked a very conspicuous star of the 9·0 mag. *n.p.* it, which is not in the *Durchmusterung* nor in Bond's *Zones* 46 and 47, while it occurs in zone 48 as a * 11 mag. As the Harvard *Zones* contain stars down to the 12–13 mag. (except in very crowded places, of which this is not one) or on Argelander's scale to about the 11th mag., the star *n.p.* the red one appears to be variable. It is $16^s.7$ *p.* and 103″·0 *n.* of Schj. 109, its position being for 1855

h	m	s	°	′
8	23	56·3	+0	20·3.

The only place where I have found this star mentioned, besides Harvard Zone 48, is the Munich Catalogue of Stars, between +3° and −3° Decl., where it is stated to be of the 10th mag., and the star *s.f.* of the 9th. The latter is of the 8·5 mag. in the *Durchmusterung*.

The Observatory, Dunsink,
April 1879.

Observations of Absorbing Vapours upon the Sun.
By Professor E. Leopold Trouvelot.

In a letter published in vol. xxxiii., page 63, of the *Monthly Notices of the Royal Astronomical Society*, November 1872, Mr. Chacornac gives an account of an interesting observation of his, entitled, "On a Volcanic Appearance in the Sun." Although I do not fully understand what Mr. Chacornac means

by "Une flamme cratériforme représentant un orifice volcanique en ignition," yet, as one of my observations seems to have some relation with his own, there may be a certain interest in recording it.

As I was observing the Sun with the spectroscope at the Harvard College Observatory on the morning of July 28, 1872, at $9^h\ 0^m$, and sweeping its surface with the narrow slit of the instrument, my attention was attracted by a large black spot crossing obliquely the C line, and projecting on each side upon the spectrum. By conveniently adjusting the spectroscope, it was very easy to recognise its position, form, and size. It was situated on the southern hemisphere of the Sun, in the vicinity of a very large sunspot which was on its second return, and then not far from the east limb. This remarkable object, which very nearly formed a straight line, was very narrow and slender; but much wider towards its southern extremity, from whence it gradually decreased as it advanced northward, until it terminated on this side in a very acute extremity. From its southern end to about half its length it projected upon the spectrum on both sides of the C line, to a distance equal to about three or four times the width of this line. Its length was considerable. It began at a small distance to the south-west of the large sunspot, and thence, inclining to the west, it advanced northwards towards the centre of the Sun, in the vicinity of which it terminated; the angle it subtended being equal at least to one-sixth of the diameter of the Sun.

As soon as this observation was completed, the same part of the Sun was observed telescopically with different power eyepieces, and scrutinised with attention; but, to my surprise, I could not see the least trace of a spot or mark indicating the cause of the phenomenon so prominent on the C line. Even no difference was noticed in the granulations covering that part of the Sun from whence the absorption proceeded. However, the phenomenon had not disappeared during the time I had removed the spectroscope, as this instrument, having been replaced, continued to show the black spot sharply defined on the spectrum.

On July 29, at $9^h\ 0^m$, the slit of the spectroscope was again directed in the vicinity of the large southern sunspot, and soon the dark absorbing spot seen the day before was found in nearly the same place. However, its size was reduced, it was not so black and sharp, and it no longer projected on the spectrum, its absorbing quality having evidently diminished. This part of the Sun being also examined with the telescope, nothing unusual was noticed.

However, Mr. Chacornac had observed the Sun on the same day, at $9^h\ 0^m$ A.M., or, if we take into account the difference of longitude, about $5^h\ 30^m$ before I observed it in Cambridge; and then, according to his expressions, he saw, "Une flamme cratériforme représentant un orifice volcanique en ignition. . . . d'une

teinte bleuâtre nettement décidée . . . et soustendant un angle d'environ un septième du diamétre solaire."

As the French astronomer saw this "flamme" with the telescope $18^h\ 30^m$ after my first observation, and $5^h\ 30^m$ before the second, it might be inferred that the phenomenon had increased, and was in a particular state of visibility at the moment of his observations, since I could not, with the telescope alone, see the least traces of it before or after his observations. It seems difficult to admit that Mr. Chacornac and I have been observing a different phenomenon, since the position of this object, so near the large sunspot, could not be mistaken; and besides, by its unusual size, it is not very likely that another of such length should have formed in the same vicinity in a few hours.

For the explanation of this curious phenomenon it does not seem necessary to call forth something analogous to Ulloa's hole, as Mr. Chacornac has done, since it seems rather more simple to think that it was due to some hydrogenated vapours strongly absorbing the rays of the Sun, and which had been expelled from the interior of the large sunspot in the vicinity, as some of my observations indicate, and as will be shown presently.

May 16, 1872. The Sun having been examined with the spectroscope, several black spots, darker than the C line, made their appearance on this line, and projected on the spectrum towards the side of less refrangibility. These objects issued from an area of the Sun enclosed between a group of sunspots then very near the western limb.

July 17, 1872. A very dark spot was seen crossing the C line; no trace of it was seen on D^3 or on any other part of the spectrum.

April 16, 1873, $9^h\ 0^m$ A.M. A strong dark spot was observed on the C line; it issued from a part of the Sun situated between two groups of sunspots not very far from the western limb. By slowly moving the slit the complicated form of this object showed itself as it passed over it. It was very irregular, curved, with wider and darker places, which sometimes projected upon the spectrum, either on one or both sides of the C line. Its length was considerable, as it occupied almost the whole space between the two groups of sunspots, which were quite distant. When observed with the telescope, no traces of it were found.

September 22, 1873, $9^h\ 25^m$ A.M. A very curious group of four small dark spots, disposed in a lozenge shape, were seen projecting on the spectrum on the red side of the C line, and at some distance from it. The furthest of these spots was upon the fine line 690 of Kirchhoff's maps. These spots appeared entirely disconnected from the C line, and perfectly independent of each other. They were in rapid motion, and were seen gradually moving together towards the C line, which they reached in less than five minutes; while at the same time they diminished gradually in size and in depth of tint until they vanished.

September 28, 1873. A similar phenomenon was observed in the south-east of two large groups of sunspots.

October 29, 1873. A sunspot was crossing the western limb, when it was observed that the spectrum of the chromosphere above it was vacant and replaced by a dark spot projecting outside of the C line.

November 5, 1873, $10^h\ 30^m$. While observing the surface of the Sun between two sunspots situated at some distance from the west limb, a large black spot appeared upon the C line and projected on each side upon the spectrum, but to a greater distance on the violet side, where it extended five or six times the width of this line. Its form was that of the letter C. This part of the Sun being examined with the telescope, a bluish kind of a spot, much diffused in outlines, was seen where the spot on the C line appeared. At $2^h\ 0^m$ P.M. the spot of absorption was no more to be seen, but in its very place a small group of three sunspots had formed since the observation made in the morning.

November 6, 1873, $10^h\ 30^m$. A spot of absorption issuing from the vicinity of the small group of sunspots formed the day before was observed on the C line. With the telescope faint bluish spots could be seen on this part of the Sun. This spot of absorption, so prominent upon the C line, was not visible on the D lines, or on any other seen in the field of view. This spot was quite large, but narrow and branching off in several places. While sweeping along it with the slit, at one point near its eastern extremity the black spot, then projecting towards the red end, passed suddenly on the violet side of the C line, where it extended much further than it did on the other side. The following day it was found that where the absorbing vapour had been observed a long row of small sunspots had formed in its place, which united the two large spots by a dozen or more smaller ones.

December 24, 1873. Four small elongated dark spots, almost united end to end, were seen projected on the spectrum near the C line, on the side of greater refrangibility, where they occupied about three-fourths the width of the spectrum. They formed almost a straight line, which was a little inclined to the C line, its nearest extremity being separated from it by an interval about twice the width of this line, while the furthest was four or five times this distance. These spots were not in apparent communication with the C line.

May 30, 1874. A sunspot was passing the west limb; a spot of absorption was observed above it on the C line in place of the brilliant spectrum of the chromosphere. A similar phenomenon to that observed on October 29, 1873.

August 26, 1874, $9^h\ 15^m$. While I was observing a moderate sized sunspot with the telescope, a small bluish cloudlike form was seen issuing from this spot, and, taking a westerly course, it moved rapidly away, while at the same time it dilated considerably, until, becoming more and more diffused, it gradually became invisible.

June 1, 1875. On the morning of that day I observed with the telescope a very large elongated bluish spot, having diffused edges, in the north-east of a group of sunspots then very active and in process of formation, and which became so conspicuous the following day.

December 12, 1875, $12^h\ 30^m$. While observing a sunspot under a brilliant facula, a long trail of bluish vapours issued from the northern corner of this spot, and had its direction north-east.

September 4, 1877. Several spots of absorption were observed on the C line, in the vicinity of a group of sunspots then in great activity; the C line being reversed in many places by brilliant faculæ. One of the spots of absorption was quite extended, and, by moving the slit along it, it projected sometimes on one side of the C line, sometimes on the other, or on both. The group of sunspots close to the place where these absorbing vapours were issuing was very active; and at $1^h\ 30^m$ a sunspot, which at $9^h\ 0^m$ appeared as a veiled spot, had made its appearance. The following day, at $9^h\ 0^m$, several spots of absorption intermingled with brilliant faculæ reversing the C line were observed in the same place where they had been seen on the 4th. One of these spots was quite large and prominent, and close to the sunspot formed the afternoon before.

March 15, 1878. Quite a large spot of absorption was observed on the C line, and projected on each side upon the spectrum. This spot was issuing from the vicinity of a group of spots, being between it and a veiled spot situated about the centre of the Sun. This absorbing spot was visible on no other line in the spectrum except the C line.

May 26, 1878. In the vicinity of a large and important group of sunspots, situated in the east of the Sun, the C line was partially reversed in several places, and many dark absorbing spots were seen projecting on both sides of this line.

May 27, 1878. A very interesting phenomenon was observed on the preceding sunspot of the large group, where the spots of absorption were observed the day before. The phenomenon was the more remarkable because the spot on which it took place could be easily compared with the following one of the group, at a small distance from it. The umbra of the preceding sunspot was invaded by a bluish or purplish kind of a fog, which totally obscured its contour, and rendered the interior of the penumbra very diffused and indistinct. The phenomenon was so characteristic that I at first thought the focussing was bad, and tried to readjust it; but it was soon found that such was not the case, as the umbra of the following spot was admirably well defined, while the foggy appearance remained the same on the preceding spot. The spectrum of this spot was much darker than that of the following, and the C line was much more swollen on it than on the other. The phenomenon continued about the same for several days, and it was only on June 1 that both umbræ and their spectra

appeared the same; this change corresponded to a decrease of size of the preceding spot. On May 28 the C line was reversed on several places in the vicinity of this spot, and several dark absorbing spots were seen projected on both sides of the C line.

It is seen from these observations that on several occasions the dark spots seen on and about the C line preceded by a few hours or even days the opening of sunspots, as if they were, like the faculæ, the precursors of solar spots. The fact that these dark spectral spots were observed in every case in the vicinity of solar spots in full activity, or upon the very umbræ of such spots, is sufficient, it seems, to prove that absorbing vapours, just as well as intensely luminous gases, are ejected from the interior of the Sun through the opening of the solar spots, even if the direct observations had not shown these vapours issuing from the spots and moving away from them on the surface of the Sun.

Cambridge, U.S., January 12, 1879.

Ephemeris for Physical Observations of Jupiter, 1879. By A. Marth, Esq.

G.M.T.	Angle of Position of ♃'s Axis.	Longitude of ♃'s Meridian directed to the Earth.	Diff.	Latitude of Earth above ♃'s Equator.	Sun above ♃'s Equator.	Annual Parallax.	Equat. Diam.	Greatest Phase.	Corr. of Long.
1879.	°	°		°	°	°	″	″	°
May 20	335·63	145·66		+1·12	+0·71	−11·43	38·30	0·380	+0·57
			4352·80						
25	335·56	178·46		1·16	0·73	11·57	38·89	·396	·58
			2·86						
30	335·49	211·32		1·20	0·75	11·65	39·50	·407	·59
			2·93						
June 4	335·44	244·25		+1·24	+0·78	−11·67	40·13	·415	+0·59
			4353·00						
9	335·39	277·25		1·28	0·80	11·61	40·78	·417	·59
			3·07						
14	335·36	310·32		1·32	0·82	11·48	41·45	·415	·57
			3·14						
19	335·33	343·46		1·35	0·85	11·28	42·13	·406	·55
			3·21						
24	335·31	16·67		1·38	0·87	10·99	42·81	·393	·53
			3·27						
29	335·30	49·94		1·41	0·89	10·63	43·50	·373	·49
			3·34						
July 4	335·30	83·28		+1·43	+0·92	−10·19	44·18	·348	+0·45
			4353·41						
9	335·31	116·69		1·46	0·94	9·66	44·85	·311	·40
			3·47						
14	335·32	150·16		1·48	0·96	9·06	45·50	·284	·36
			3·53						
19	335·34	183·69		1·49	0·98	8·37	46·13	·246	·31
			3·58						
24	335·38	217·27		1·50	1·01	7·61	46·72	·206	·25
			3·63						
29	335·42	250·90		1·51	1·03	6·78	47·26	·165	·20
			3·66						

h G.M.T.	Angle of Position of ♃'s Axis.	Longitude of ♃'s Meridian directed to the Earth.	Diff.	Latitude of Earth | Sun above ♃'s Equator.		Annual Parallax.	Equat. Diam.	Greatest Phase.	Corr. of Long.
1879.	°	°		°	°	°	″	″	°
Aug. 3	335·47	284·56		+1·51	+1·05	−5·88	47·75	·126	+0·15
			4353·69						
8	335·53	318·25		1·51	1·07	4·92	48·17	·089	·11
			3·71						
13	335·59	351·96		1·51	1·10	3·91	48·53	·056	·07
			3·72						
18	335·67	25·68		1·50	1·12	2·86	48·80	·030	·04
			3·71						
23	335·75	59·39		1·49	1·14	1·78	48·99	·012	+·01
			3·69						
28	335·83	93·08		1·47	1·16	−0·68	49·09	·002	·00
			3·66						
Sept. 2	335·92	126·74		+1·45	+1·19	+0·43	49·10	·001	·00
			4353·62						
7	336·01	160·36		1·43	1·21	1·54	49·02	·009	−·01
			3·57						
12	336·11	193·93		1·41	1·23	2·63	48·84	·026	·03
			3·50						
17	336·20	227·43		1·39	1·25	3·69	48·58	·050	·06
			3·43						
22	336·29	260·86		1·36	1·28	4·71	48·24	·081	·10
			3·34						
27	336·37	294·20		1·33	1·30	5·68	47·82	·117	·14
			3·25						
Oct. 2	336·44	327·45		+1·31	+1·32	+6·59	47·34	·155	−0·19
			4353·15						
7	336·51	0·60		1·28	1·34	7·43	46·80	·196	·24
			3·05						
12	336·56	33·65		1·26	1·36	8·20	46·21	·236	·29
			2·95						
17	336·61	66·60		1·24	1·38	8·89	45·58	·274	·34
			2·84						
22	336·64	99·44		1·22	1·41	9·50	44·92	·308	·39
			2·74						
27	336·65	132·18		1·20	1·43	10·03	44·25	·338	·44
			2·63						
Nov. 1	336·65	164·81		+1·18	+1·45	+10·47	43·56	·363	−0·48
			4352·54						
6	336·63	197·35		1·17	1·47	10·82	42·86	·382	·51
			2·45						
11	336·60	229·80		1·16	1·49	11·10	42·17	·394	·54
			2·35						
16	336·56	262·15		1·16	1·51	11·29	41·48	·401	·55
			2·26						
21	336·50	294·41		1·15	1·53	11·40	40·81	·403	·57
			2·19						
26	336·43	326·60		1·15	1·55	11·43	40·15	·398	·57
			2·11						
Dec. 1	336·36	358·71		+1·15	+1·58	+11·39	39·51	·389	−0·56
			4352·05						
6	336·27	30·76		1·16	1·60	11·28	38·90	·376	·55
			1·98						

0h G.M.T.	Angle of Position of ♃'s Axis.	Longitude of ♃'s Meridian directed to the Earth.	Diff.	Latitude of Earth above ♃'s Equator.	Latitude of Sun above ♃'s Equator.	Annual Parallax.	Equat. Diam.	Greatest Phase.	Corr. of Long.
1879.	°	°		°	°	°	″	″	°
Dec. 11	336·17	62·74		1·17	1·62	11·10	38·31	·358	·54
			1·92						
16	336·07	94·66		1·18	1·64	10·86	37·75	·339	·51
			1·88						
21	335·96	126·54		1·20	1·66	10·56	37·22	·315	·49
			1·83						
26	335·85	158·37		1·22	1·68	10·21	36·72	·291	·45
			1·80						
31	335·74	190·17		1·24	1·70	9·80	36·25	·264	·42
			4351·76						
1880.									
Jan. 5	335·63	221·93		+1·26	+1·72	+9·35	35·81	0·238	−0·38

Assumed daily rate of rotation 870°·60. The "annual parallax" is the difference of the Jovicentric longitudes of the Sun and the Earth, reckoned in the plane of *Jupiter's* equator. The last column gives the correction which is to be applied to the "longitude of ♃'s meridian directed to the Earth," in order that it may refer to the meridian which bisects the illuminated disk.

The inclinations γ and the ascending nodes Γ of the orbits of the four satellites in reference to the plane of *Jupiter's* equator are the following, the nodes being reckoned from the descending node of the equator on the planet's orbit, or from the vernal equinox of *Jupiter's* northern hemisphere:—

	Sat. I.		Sat. II.		Sat. III.		Sat. IV.	
	γ_1	Γ_1	γ_2	Γ_2	γ_3	Γ_3	γ_4	Γ_4
1879.	°	°	°	°	°	°	°	°
Feb. 19	0·0097	17·3	0·4597	25·27	0·1908	268·20	0·3246	329·61
April 20	·0097	14·8	·4605	23·25	·1902	267·77	·3249	329·54
June 19	·0098	12·5	·4614	21·23	·1896	267·38	·3253	329·49
Aug. 18	·0099	10·1	·4624	19·21	·1890	267·00	·3257	329·45
Oct. 17	·0100	7·9	·4634	17·20	·1883	266·64	·3262	329·44
Dec. 26	0·0102	5·7	0·4644	15·19	0·1876	266·30	0·3267	329·46

On the Desirability of photographing Saturn and Mars at the next Conjunction. By A. A. Common, Esq.

In the December 1878 Number of the *Notices* of this Society the particulars of the conjunction of *Saturn* and *Mars* on June 30, 1879, are given by the Astronomer Royal.

I trust that those astronomers who can will take advantage of this excellent opportunity of testing the relative actinic intensity of light of the two planets.

As they can then be taken under the same conditions, and if differently prepared plates are used—that is the ordinary wet plate and iodised collodion, and those dry plates that are more

sensitive to the red rays—the different effects of the colours of the planets might be made apparent.

Perfection of image would not be of so much importance as the effect in producing chemical action on the plate.

To show the possibility of doing this, I beg to lay before the Society two photographic plates, one with a row of pictures of *Jupiter* (showing the effect of a slight difference in the exposure on the image both as to size and density), and the other a picture of *Saturn*, all taken with an exposure of about $2\frac{1}{2}$ seconds in the case of *Saturn*, and still less in the case of *Jupiter*, by an eighteen-inch silver-on-glass Newtonian telescope.

March 1879.

Note on Large Telescopes, with suggestions for mounting Reflectors.
By A. A. Common, Esq.

The question how an increase of telescopic power may be best attained is well worth discussing, and I propose to offer some suggestions how an advance on our present means may be most readily made.

The question turns on the relative capacity of the refracting and reflecting telescope to give this increase,* and without attempting to decide which kind will eventually be found best, it is possible, I think, to show that practically the advantage is on the side of the reflector.

Although up to a certain size (taking 26 inches as the largest yet made) the refractor equals or surpasses the reflector in light-grasping power, and has certain advantages in use, as, for instance, the permanence of adjustment, readiness at all times for work, and freedom from great atmospheric disturbance, and, for its disadvantages, great length and chromatic aberration which prevents its complete use in photographic and spectroscopic work; while the reflector has, for its advantages, shorter focal length and total absence of chromatic aberration, and, for its disadvantages, want of permanency of adjustment, greater atmospheric disturbance, and a reflecting surface that requires constant attention and frequent renewal; these advantages and disadvantages do not much affect the question, for it is not on these grounds that it can be decided.

For at this point (viz. a 26-inch refractor or the equivalent sized reflector) the difficulties in producing the two kinds, or, in

* Since this paper was drafted and the conditions laid down, I have received from the author, Mr. Howard Grubb, a copy of his paper "On the Great Telescopes of the Future," published in the *Scientific Transactions* of the Royal Dublin Society, a paper I read with much interest, though I do not agree with him on several points. In it this question is most fully discussed; and although the writer does not advocate any particular kind, there is a very decided leaning to the reflector of speculum metal, the reflecting power of which he hopes to be able to improve.

other words, the cost—for that really represents the various difficulties expressed in terms of pounds, shillings, and pence—is greatly in favour of the reflector; and at that size, or a little above, the production of the refractor may for the present be said to stop, owing to the great difficulty (almost impossibility) of producing the disks of glass of sufficient purity for the purpose of the optician, and of working and supporting the object glass when made; and although these difficulties might by great care and skill be in a manner overcome, there remains the important fact that, owing to the absorption of the light by the glass, which is necessarily thicker as the aperture of the object glass increases, a point is soon reached when the hitherto greater light-grasping power of the refractor is equalled by the reflector, and beyond which it rapidly falls behind the latter, so that it is possible to conceive an object glass so large that it would let but a small fraction of the incident light through. This is of course well known, but it does not seem to have had that effect on the minds of astronomers that we would expect. It certainly does decide it beyond any doubt as far as present conditions hold. We are therefore obliged to turn to the reflector for the purpose in view; and the point then arises, which of the two surfaces—speculum metal or silver—is best for the purpose?

Sir John Herschel, in his book on the *Telescope*, gives for a Newtonian reflector with the mirrors of Lord Rosse's metal, 0·436 as the fraction of incidental light reflected; while, for the like telescope with mirrors of solid silver, he gives 0·824; and, allowing that speculum metal might be improved in reflecting power, and that the surface of silver deposited by chemical action may be less reflective than solid silver, a very large margin is left in favour of the silver-on-glass; and, considering that the mirror of speculum metal has the figure endangered if not destroyed every time it is repolished, while that once given to a glass mirror is permanent, and that there is not any difficulty, as I shall presently show, in producing this surface of silver, no choice is left as to which is best. As to any difficulty in producing glass disks—not necessarily by the glass manufacturer—for the purpose, there would not be more in any case than that met with in producing disks of speculum metal, while the weight would be in favour of the glass.*

* Mr. Howard Grubb, in the paper already referred to, has dismissed the claims of the silvered glass mirror, in a rather summary manner, in these words:—

"As regards silver-on-glass mirrors, it is hardly worth discussing their relative powers of permanence, as at the present date the art of glass-making has not arrived at that degree of perfection that will permit makers to undertake disks of any kind of suitable glass of six feet diameter; but I may mention that this is perhaps not to be much regretted, as the difficulty of preserving a silvered surface of large size would almost amount to an impossibility, and the process of silvering when the mirror is of large dimensions becomes most formidable; and, finally, it is possible that all the advantages of the silvered glass mirrors, without their corresponding disadvantages, may be secured by

The principle of mounting, whether Gregorian, Cassegranian, Herschelian, or Newtonian, is, and must be, a matter of taste. When we consider that the Melbourne reflector (the great instance of the Cassegranian principle) has—using, we presume, the large mirror only—produced photographs showing—as some of them do—such detail as the small craters between *Stadius* and *Copernicus*, and as a Cassegranian telescope failed to show the outer satellite of *Mars* at the last opposition, while it was readily seen in England with an 18-inch Newtonian under less favourable conditions, we must come to the conclusion that the principle or its adaptation is somewhere at fault.

But the simplicity of the Newtonian, and the ease with which the adjustments are made, and the favourable position given to the observer, are enough, in my opinion, to make it preferable; although, if very large sizes were attempted, it might be necessary to use the Herschelian principle, or a modification of it, if any great difficulty were found in the making of the flat mirror.

Having, then, by this process of selection got the silver-on-glass reflector on the Newtonian principle, it becomes necessary to consider the mounting; and here we come to what may be regarded as the vital point; for on the proper mounting of the reflector, so as to point it to any object in the heavens, and follow that object in its diurnal motion, while retaining all the conditions that are favourable to the best performance of the optical part, a great deal depends. As far as I know, no endeavour has been made to really find out these favourable conditions and make the mounting suit them, except in a partial manner.

I have endeavoured to find them out, and propose to indicate how they ought to be attained. They are as follows:—

1. No tube properly so called.

2. No mass of metal either below or at the side of the line joining the large and small mirrors.

3. An equatoreal mounting capable of direction to any part of the visible heavens, and of continued observation past the meridian without reversal.

4. An efficient means of supporting the mirror without flexure.

5. Driving clock. Circles to find or identify an object and motions taken to eye end.

6. A collimator for the ready adjustment of the mirrors.

other means—a matter which I shall speak more of further on"; the other means alluded to being a metal of superior reflecting power. Afterwards, in this paper, he admits that the difficulties in the case of the glass disk might be overcome, as it has been in case of the metal, without the aid of the specialist.

And here I might mention that, if it is a fact that the refractor at 35 inches aperture is equalled by the reflector of speculum metal of that size, it is hardly necessary to speak of disks of optical glass of 40 inches diameter, which when made would not nearly equal the reflector, unless we find some great—at present unknown—advantage in the refractor.

7. Such a construction of mounting as to give the greatest amount of steadiness with the least amount of friction.

8. An effectual means of resilvering the mirrors and of protecting them from dew.

9. A safe, steady, and easily adjusted platform for the observer, allowing about two hours' continuous observation without the necessity of any motion, except that from the observer's place, and of ready access.

10. A suitable locality for the erection of the telescope.

The first condition, that there shall be no tube, as such, is met by the use of a light, open, braced framing, by preference square, and which, by the use of steel tubes and rods, could be made of the required rigidity with extreme lightness. The second condition, that there shall not be any mass of metal between the large and small mirrors, is, like the first, aimed at the reduction of the atmospheric disturbance. To point out what is meant, we may take, as an example of what under these conditions would be considered the worst possible way to mount a reflector, that shown on page 134 of Newcomb's *Popular Astronomy*; and, as an approach to the best, that of the Melbourne reflector, supposing the mirror at that part where the diagonal bracing begins, and above the declination axis. The third condition indicates as the position of the mirror some point symmetrically above the polar axis, as in the mounting of Mr. Lassell's 4-foot telescope; but with this difference, that the polar axis would not be forked, but come directly under that part of the mounting bearing the mirror, and be sufficiently prolonged above the upper bearing or neck to allow a forked counterpoise to the framework necessary to carry the small mirror. The fourth condition has been so well met in the Melbourne telescope in the case of a heavy metal speculum, that it could not fail to do with glass; though something more simple might possibly be found to answer with this material in large sizes, as it has been found to answer perfectly with 18 inches. The plan suggested is this: the three primary levers bear at their extremities, instead of the secondary and tertiary systems, six flat plates, so made as to present for a bearing a broad ring, and so large as to form a circle of rings or plates almost touching and each coming under the mirror; so that, if it is conceived to be divided into six triangles by radial lines at equal distances, a ring would be under each, almost touching the straight sides; while for edge suspension three flat metal bands are connected to three equidistant points about one-twelfth of the diameter from the edge of the mirror, and each band going two-thirds of the way round the mirror.

The fifth and sixth conditions offer no difficulty. The seventh condition as regards stability is easily met, and as regards the friction, particularly as to the movement in right ascension, there is a way, by the use of the floating power of mercury, to so take off the weight from the bearing by making the polar axis of cast iron, hollow and cylindrical, and of sufficient length and

size to displace the requisite quantity of mercury (placed in another cylinder, slightly larger, in which the polar axis will turn) to reduce it to any amount. The eighth condition as regards the silvering of the glass surface is not so difficult to meet as might have been expected; as it has been found quite practicable to silver an 18-inch mirror by simply putting a band of suitable material round the edge, so as to form a dish with the mirror as the bottom, pouring in the solutions properly filtered, and allowing the silver to deposit, thereby getting a really good film, we need not anticipate that there would be any difficulty with large sizes. As to protecting the mirrors from dew when a mirror is uncovered for a night's work, the temperature of the air, as a rule, falling more rapidly than the mirror parts with its heat, prevents dewing, and it is only necessary to have some covering vertically above to prevent the dew actually falling on the mirror. A screen for this purpose could be made and used without destroying the first condition. The ninth condition is of great importance to the observer. There is nothing in my opinion which would equal an arrangement similar to the altazimuth mounting of Herschel's largest telescope revolving round the Equatoreal, but of course quite detached therefrom, with such a width of platform as to give say two hours' observation on the meridian, and either with the sloping sides for the platform to work on, or with sides curved to such a radius as to keep the platform a constant distance from the telescope at any elevation. Such a platform properly counterpoised would be safe, steady, and easily accessible by a ladder or stairs, while the open character of the structure is not unfavourable to the telescope.

The last condition being beyond the scope of this paper, and involving considerations of such a different character, I propose to leave it for independent discussion at some future time.

March 31, 1879.

On some Formulæ for expressing the value of the Excentric Anomaly etc. in terms of the Mean Anomaly. By M. A. De Gasparis.

Il peut être utile, pour le calcul des perturbations, d'exprimer la valeur de l'anomalie excentrique, vraie, du rayon vecteur, des coordonnées héliocentriques, etc., en fonction de l'anomalie moyenne, donnée en parties du rayon. J'ai trouvé les formules suivantes :—

$$E = \frac{M}{1-e} - \frac{M^3}{6}\frac{e}{(1-e)^4} + \frac{M^5}{120}\frac{e+9e^2}{(1-e)^7} - \frac{M^7}{5040}\frac{e+54e^2+225e^3}{(1-e)^{10}} \cdots$$

$$(1-e^2)^{-\frac{1}{2}}\sin v = \frac{M}{1}\frac{1}{(1-e)^2} - \frac{M^3}{6}\frac{1+3e}{(1-e)^5} + \frac{M^5}{120}\frac{1+24e+45e^2}{(1-e)^8} - \frac{M^7}{5040}\frac{1+97e+947e^2+1755e^3}{(1-e)^{11}} \cdots$$

$$\frac{\gamma}{a} = 1 - e + \frac{M^2}{2}\frac{e}{(1-e)^2} - \frac{M^4}{24}\frac{e+3e^2}{(1-e)^5} + \frac{M^6}{720}\frac{e+24e^2+45e^3}{(1-e)^8}$$

$$- \frac{M^8}{40320}\frac{e+97e^2+947e^3+1755e^4}{(1-e)^{11}} \cdots$$

$$\frac{z}{a \sin i} = (1-e)\sin(\pi-\phi) + \frac{M}{1}\sqrt{\frac{1+e}{1-e}}\cos(\pi-\phi) - \frac{M^2}{2}\frac{\sin(\pi-\phi)}{(1-e)^2}$$

$$- \frac{M^3}{6}\sqrt{\frac{1+e}{1-e}}\frac{\cos(\pi-\phi)}{(1-e)^3} + \cdots$$

a, i, π, ϕ étant le demi-grand axe, l'inclinaison, et les longitudes du périhélie et du nœud.

Les symboles (m_1, x_1, y_1, z_1), (m_2, x_2, y_2, z_2) sont les masses et les coordonnées des planètes troublées et troublantes au temps t. J'ai trouvé qu'au temps T, après le temps t, on peut exprimer par une série la correction à faire aux coordonnées *elliptiques* x_1, y_1, z_1, pour avoir les coordonnées dans l'orbite troublée. Le coefficient de T^4 dans cette série, sauf un facteur connu de l'ordre m_2, est (pour la correction de x_1) :—

$$\frac{x_1}{r_1^3\rho_{12}^3} - \frac{x_2}{r_2^3\rho_{12}^3} - \frac{(m_1+m_2)(x_2-x_1)}{\rho_{12}^6} + \frac{(1+m_2)x_2}{r_2^6} + \frac{m_1x_1}{r_1^3r_2^3} + \frac{m_1(x_2-x_1)}{r_1^3\rho_{12}^3}$$

$$- \frac{6(x'_2-x'_1)\rho'_{12}}{\rho_{12}^4} + \frac{15(x_2-x_1)\rho'^2_{12}}{\rho_{12}^5} + \frac{6x'_2r'_2}{r_2^4} - \frac{12x_2r'^2_2}{r_2^5}$$

$$- \frac{3(x_2-x_1)^2}{\rho_{12}^5} \qquad \left\{\frac{x_1}{r_1^3} - \frac{x_2}{r_2^3} - \frac{(m_1+m_2)(x_2-x_1)}{\rho_{12}^3}\right\} - \frac{3(x_2-x_1)(x'_2-x'_1)^2}{\rho_{12}^5}$$

$$- \frac{(x_2-x_1)(y_2-y_1)}{\rho_{12}^5}\left\{\frac{y_1}{r_1^3} - \frac{y_2}{r_2^3} - \frac{(m_1+m_2)(y_2-y_1)}{\rho_{12}^3}\right\} - \frac{3(x_2-x_1)(y'_2-y'_1)^2}{\rho_{12}^5}$$

$$- \frac{3(x_2-x_1)(z_2-z_1)}{\rho_{12}^5}\left\{\frac{z_1}{r_1^3} - \frac{z_2}{r_2^3} - \frac{(m_1+m_2)(z_2-z_1)}{\rho_{12}^3}\right\} - \frac{3(x_2-x_1)(z'_2-z'_1)^2}{\rho_{12}^5}$$

$$- \frac{3x_2^2}{r_2^5}\left\{\frac{m_1(x_2-x_1)}{\rho_{12}^3} + \frac{(1+m_2)x_2}{r_2^3} + \frac{m_1x_1}{r_1^3}\right\} + \frac{3x_2}{r_2^5}(x'^2_2+y'^2_2+z'^2_2-r'^2_2)$$

$$- \frac{3x_2y_2}{r_2^5}\left\{\frac{m_1(y_2-y_1)}{\rho_{12}^3} + \frac{(1+m_2)y_2}{r_2^3} + \frac{m_1y_1}{r_1^3}\right\} - \frac{3x_2z_2}{r_2^5}\left\{\frac{m_1(z_2-z_1)}{\rho_{12}^3} + \frac{(1+m_2)z_2}{r_2^3} + \frac{m_1z_1}{r_1^3}\right\}.$$

Les symboles x', y', z' sont les derivées premières par rapport au temps ; ρ_{12} est la distance mutuelle des masses m_1 et m_2.

Naples, 11 *mars* 1879.

On the Probable Presence of Oxygen in the Solar Chromosphere.

By Arthur Schuster, Ph.D.

When Dr. Henry Draper's Paper "On the Presence of Oxygen in the Sun" appeared I was engaged in an investigation of some lines of oxygen which appear only at a temperature lower than that which gives the ordinary spectrum of oxygen. As I considered it likely that if oxygen was present in the Sun, it would show dark lines corresponding to one of its spectra, though it might show bright lines corresponding to another, Dr. Draper's researches induced me to see whether the lower temperature spectrum of oxygen, which I called the compound line spectrum, was reversed in the Sun. I have given evidence in *Nature*, vol. xvii., p. 148, that this indeed is the case. All four lines of the compound spectrum seem to be reversed in the Sun. I considered it also probable, for obvious reasons, that oxygen would reach up to a comparatively high level in the solar chromosphere, and would make itself conspicuous in that layer which commonly passes under the name of the chromospheric layer. I looked for the lines in Professor Young's list, but could not find them. A few weeks ago, however, I found that, owing to some accident, I had only referred to the preliminary Catalogue. Professor Young's final Catalogue contains indeed the two most striking out of the four lines of the spectrum in question. Their wavelengths are 5329·1 and 5435·6. Besides these two lines the spectrum contains a red line and a blue line. These lines, lying in a less luminous part of the spectrum, are easily missed. Yet the red line is strong and very characteristic. I should have expected that it would make its appearance together with the green lines. Its absence has induced me to insert the word "probable" into the title of this Note. I do not, however, believe that this absence is fatal to the explanation which I have offered of the two other lines; for not only does Professor Young include these lines in his list, but he gives them the same relative intensity which they have in the spectrum of oxygen. Professor Young's list includes 65 lines between D and E. Of these about 46 have been identified with certainty. There are therefore only about 19 left for identification, and two out of these 19 are coincident with lines of oxygen.

Erratum.

p. 365, line 4, read:—

$$p - p_0 = +0{\cdot}0010 + 0{\cdot}0015 = +0{\cdot}0025.$$